Mercury and Mink
I. The Use of Mercury Contaminated Fish as a Food for Ranch Mink

G. Wobeser, N. O. Nielsen and B. Schiefer*

ABSTRACT

Adult female and juvenile ranch mink were fed rations containing 50 and 75% of fish containing 0.44 ppm total mercury over a 145 day period. There was no clinical or pathological evidence of intoxication in these animals and mercury concentrations in tissue appeared to be at a level below that associated with toxicity.

RÉSUMÉ

On a servi à des visons femelles, jeunes et adultes, durant 145 jours, des rations contenant 50 et 75% de viande de poisson dont la teneur en mercure s'élevait à 0.44 ppm. Ces animaux ne manifestèrent aucune évidence clinique ou pathologique d'hydrargyrisme. La teneur de leurs tissus en mercure s'avéra inférieure à celle que l'on considère toxique.

INTRODUCTION

Mercury pollution of natural waters has been recognized in many areas of the world. Intoxication from the consumption of contaminated fish from these waters has been reported in humans, cats and sea birds (5).

A national survey conducted in 1971 showed that many of the major water systems in Canada were contaminated with mercury to some degree (1). Little information is available on the effects of methyl mercury, the most common form of mercury in fish (1, 7), upon piscivorous mammals. An understanding of the possible hazards of mercury in fish for piscivorous animals is important because freshwater fish are used as a large portion of the diet of ranch mink in some areas of Canada and such information would also be of value in assessing the risk to wild piscivorous animals dependent upon fish from contaminated waters. The present experiment was designed to study the safety of fish from a polluted water body as a dietary constituent for ranch mink.

MATERIALS AND METHODS

Experimental design

Twenty-five adult female mink of the pearl color phase and their litters (approximately one month of age) were purchased from a local mink rancher and moved to an unused area of the mink ranch. The rancher was responsible for caring for these mink in the normal manner used on the ranch. The mink were divided into three groups: group I contained five females and 19 kits, group II contained ten females and 34 kits and group III contained ten females and

*Department of Veterinary Pathology, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0.

Based on a thesis submitted by G. Wobeser in partial fulfilment of the requirements for the Ph.D. degree at the University of Saskatchewan.

Submitted March 14, 1975.

29 kits. Each family group was initially maintained in a single cage. Later, after weaning of the kits at about day 40, the litters were divided and the young mink placed either singly or two together in a pen.

The mink in group I served as controls and received the normal ranch ration which was prepared twice weekly. The exact composition of this ration varied somewhat over the period of the study depending upon the availability of ingredients. Its approximate composition per 100 kg was:

Chicken offal	50 kg
Beef tripe and offal	30 kg
Cereal	10 kg
Rabbit carcasses[1]	5 kg
Fish[2]	5 kg

This ration contained 0.5% salt (NaCl). Several samples of this ration were analyzed for mercury content over the experimental period and the mercury content was found to be consistently less than 0.1 parts per million (ppm).

The mercury contaminated fish used in this study were freshwater drum *(Aplodinotus grunniens)* from Lake Winnipeg, Manitoba. This species is a bottom feeding fish which is utilized largely for mink food. The fish material was supplied in a ground and frozen form by the Freshwater Institute, Fisheries Research Board of Canada, Winnipeg, Manitoba. Pooled samples of this fish contained 0.44 ± 0.02 ppm of mercury (C.K.C. Tam, 1970, *personal communication)*. This material was maintained frozen until used in the preparation of rations for groups II and III. The composition of these rations per 100 kg was:

	Group II	Group III
Fish	50.0 kg	75.0 kg
Cereal	5.0 kg	7.5 kg
Normal ranch ration	44.7 kg	17.1 kg
Salt (NaCl)	0.3 kg	0.4 kg

These rations were prepared fresh weekly and thoroughly mixed with a large electric mixer. Thereafter the rations were divided into amounts required for daily feeding, packaged in heavy plastic bags and frozen until required for feeding.

Mink were fed once daily on the cage wire in slight excess of consumption. Water was supplied *ad libitum*. The experimental period was 145 days in duration.

Sampling

Group I. One female mink and three to six juveniles were sacrificed at 30 day intervals beginning 30 days after being placed on the ration.

Groups II and III. One female and three to six juveniles from each group were sacrificed at 15 day intervals beginning 30 days after being placed on the experimental rations. In one instance in each of groups II and III two adult females were sacrificed at one time because of lacerations due to fighting. On the final date the remaining two females in each group were sacrificed.

All mink were euthanatized by the intraperitoneal injection of a saturated solution of sodium pentobarbitone[3]. The mink were weighed and a necropsy performed. The brain of the adult and one juvenile mink at each collection date were sectioned midsagitally and one half, together with portions of liver and kidney, were placed in individual plastic bags, frozen and retained for mercury analysis. The other half plus the spinal cord and the entire brain and spinal cord from the other mink in each group together with portions of liver, kidney, stomach, colon, spleen, lung, myocardium, sciatic nerve and mesenteric lymph node were immersed in ten per cent neutral buffered formalin.

After approximately ten days fixation, the brain was sectioned transversely at 5 mm intervals and these slices together with transverse sections of the cervical, thoracic and lumbar spinal cord and sections of the other organs were embedded in paraffin, sectioned at 6μ and stained with hemotoxylin and eosin.

Mercury analyses on liver, brain and kidney tissues were performed in the Department of Veterinary Physiology, Western College of Veterinary Medicine, using the digestion and extraction procedures of Uthe *et al* (6) and atomic absorption spectrophotometry as previously described (8).

[1](Lepus townsendi) obtained from a fur buyer and frozen during the winter months, thawed as needed during the remainder of the year.

[2]Locally called "tulibee" (Coregonus artedii) obtained from Last Mountain Lake, Saskatchewan.

[3]453.6 g pentobarbitone sodium (U.S.P.)
100.0 ml absolute ethyl alcohol
400.0 ml distilled water

RESULTS

Clinical findings

No clinical signs of disease were observed in any of the mink within the experimental period. No mortality occurred which could be associated with the feeding of mercury contaminated fish. There appeared to be no impairment of growth of the juvenile mink in the principal groups and in general, mink receiving the high fish rations were heavier than controls of the same sex and of similar age.

Accumulation of mercury in tissue

The mercury concentrations in the mink in groups II and III were higher than those in group I (Tables I, II, III). The concentrations of mercury in the liver and kidney increased more rapidly than did those in brain tissue. During the first 60 days adult mink had substantially more mercury in their tissues than did juveniles but the difference became less apparent later in the study.

Pathology

No gross or histological lesions suggestive for mercury poisoning were detected in any of the mink. One adult female from group I had several granulomatous lesions present in the lungs. These areas contained acid-fast bacilli and a diagnosis of tuberculosis was made.

DISCUSSION

Diets containing 50 and 75%, respectively, of fish containing 0.44 ± 0.02 ppm of mercury appeared to have no obvious adverse affects upon mink during the course of this experiment.

The distribution of mercury among liver, kidney and brain tissue of the mink in the principal groups was similar to that reported in methyl mercury poisoned ferrets (3). The maximum mercury concentrations found in the tissues of the mink, however, were approximately one order of magnitude lower than the values reported in poisoned ferrets (3). Borg *et al* (2) stated that the fatal brain level of methyl mercury in ferrets was of the order of 30 to 40 ppm. The levels of mercury found in the brain tissue of two animals in group III (7.2 and 8.3 ppm, respectively) seem to be anomalous, particularly when compared to the concentrations in liver and kidney of the same animals. The findings suggested sample contamination prior to analysis but no explanation for how this might have occurred was found.

TABLE I. Mercury (ppm) in the Liver of Mink in Groups I, II and III Fed Rations Containing 0, 50 and 75% Mercury Contaminated Fish Respectively

		Days on Trial						
Group	Age	30	45	60	75	90	105	120
I	adult	0.7		—		0.7		0.5
	juvenile	0.2		0.2		0.3		0.2
II	adult	2.1	2.7	3.9	3.9	5.7	2.2	4.1
	juvenile	0.7	1.1	1.8	3.4	4.0	2.8	2.6
III	adult	4.9	4.9	6.6	2.4	6.8	7.8	4.2
	juvenile	1.2	2.2	6.2	4.8	2.9	3.4	2.2

TABLE II. Mercury (ppm) in the Kidney of Mink in Groups, I, II and III Fed Rations Containing 0, 50 and 75% of Mercury Contaminated Fish Respectively

		Days on Trial						
Group	Age	30	45	60	75	90	105	120
I	adult	0.3		—		0.7		1.0
	juvenile	0.2		0.1		0.4		0.3
II	adult	2.0	3.1	3.4	3.3	4.5	2.4	2.6
	juvenile	0.6	1.0	1.4	2.3	2.9	2.5	1.5
III	adult	4.7	4.4	4.5	3.6	6.4	6.5	2.9
	juvenile	0.9	1.8	4.1	3.9	4.4	3.1	2.1

TABLE III. Mercury (ppm) in the Brain of Mink in Groups I, II and III Fed Rations Containing 0, 50 and 75% of Mercury Contaminated Fish

		Days on Trial						
Group	Age	30	45	60	76	90	105	120
I	adult	0.1		—		0.1		0.3
	juvenile	—		0.4		0.1		0.1
II	adult	0.6	0.9	3.2	1.0	1.1	0.4	0.5
	juvenile	0.2	0 3	0.4	0.6	0.7	0.5	0.5
III	adult	1.2	1.5	1.4	0.8	1.7	2.5	3.4
	juvenile	0.4	8.3	7.2	1.0	0.9	0.7	2.6

Adult mink initially accumulated mercury at a more rapid rate than did the juveniles. This was likely the result of higher food intake by the females during the period in which the young were partially dependent upon milk and also the rapid growth of the young mink would have a "diluting" effect upon mercury concentrations in their tissues.

On the basis of this study it appears that fish containing concentrations of mercury similar to those used could be used as a ration ingredient for ranch mink. The feeding of such fish should however, be confined to relatively short periods of time, possibly during the growth and furring out of young mink and not used for extended periods of time or for breeding animals without studies of the long term effects of low mercury intake. Also, since fish with tissue mercury levels 25 to 36 times greater than those used have been reported in Canada (4, 8), the results can not be interpreted to mean that all fish are safe for use as mink food.

ACKNOWLEDGMENTS

The authors are indebted to Mr. A. H. Campbell whose practical knowledge with regard to mink was of great assistance. The technical assistance of Miss D. Guedo is gratefully recognized.

Financial support was provided by the Medical Research Council of Canada and by Canada Department of the Environment, Fisheries Research Board of Canada.

G. Wobeser was a fellow of the Medical Research Council of Canada.

REFERENCES

1. **BLIGH, E. G.** Mercury and the contamination of freshwater fish. Manuser. Rep. Ser. Fish. Res. Bd. Can. 1088: 1-23. 1970.
2. **BORG, K., K. ERNE, E. HANKO and H. WANNTORP.** Experimental secondary methyl mercury poisoning in the goshawk (**Accipiter g. gentilis L.**) Envir. Pollution 1: 91-104. 1970.
3. **HANKO, E., K. ERNE, H. WANNTORP and K. BORG.** Poisoning in ferrets by tissues of alkyl mercury-fed chickens. Acta vet. scand. 11: 268-292. 1970.
4. **LOCKHART, W. L., J. F. UTHE, A. R. KENNEDY and P. M. MEHRLE.** Methyl mercury in northern pike (**Esox lucius**): distribution, elimination and some biochemical characteristics of contaminated fish. J. Fish. Res. Bd. Can. 29: 1519-1523. 1972.
5. **TAKEUCHI, T.** Biological reactions and pathological changes in human beings and animals caused by organic mercury contamination. In Environmental Mercury Contamination. R. Hartung and D. B. Dinman, Editors. pp. 247-289. Ann Arbour, Michigan: Ann Arbour Sci. Publ. Inc. 1972.
6. **UTHE, J. F., F. A. J. ARMSTRONG and M. P. STARNTON.** Mercury determination in fish samples by wet digestion and flameless atomic absorption. J. Fish. Res. Bd. Can. 27: 805-811. 1970.
7. **WESTOO, G.** Determination of methylmercury compounds in foodstuffs I. Methylmercury compounds in fish, identification and determination. Acta chem. scand. 20: 2131-2137. 1966.
8. **WOBESER, G., N. O. NIELSEN, R. H. DUNLOP and F. M. ATTON.** Mercury concentrations in tissues of fish from the Saskatchewan River. J. Fish. Res. Bd. Can. 27: 830-834. 1970.